Review of: Search for a Naturalistic World View by Abner Shimony

Volume I, Scientific Method and Epistemology,
pp. XIV + 333
Volume II, Natural Science and Metaphysics,
pp. VIII + 340.
Cambridge University Press, 1993

by

Michael Redhead, Wolfson College, Cambridge

In these two volumes of his collected papers, one gets a very good impression of the range of Shimony's interests. He is equally at home in epistemology, metaphysics and the detailed technicalia of theoretical physics. It is really quite remarkable to see such a variety of important papers coming from the pen of a single author. The papers cover a span of forty years, but ~~the~~ in ~~author has~~ many cases the author has added a useful section entitled 'Comment' bringing the discussion pretty thoroughly up to date.

Shimony's overall approach to investigating the nature of science is naturalistic and dialectical. That is to say, he believes that the best starting point for understanding the world is our current scientific theories but that these theories can themselves be subjected to critical scrutiny in respect of how adequately they deal with the problem of what Shimony

calls 'closing the circle', i.e. of accounting for how the knowing subject can come to acquire knowledge about the objective world. Shimony is a realist and dismisses the view that we construct our own worlds, that are all equally on a par so far as truth is concerned; or any of the instrumentalist or positivistic readings of successful theories. He has ~~much~~ general sympathy with Whitehead's philosophy, although he is critical of much of the detail, and is convinced that the basic 'building blocks' of a ~~convincing~~ satisfactory world view must incorporate some notion of proto-mentality. Essentially, Shimony's argument here is that he does not see how a purely physicalist description can accommodate the first-person, subjective aspect of human minds, and since he believes that human beings are not decisively different from a collection of physical particles and fields, that the mental aspect must project through in some way to the most elementary level. The difficulty with this argument is that, at the elementary level, we don't seem to be dealing with "mental" entities. Shimony is very honest about this problem and in his discussion of the measurement problem in quantum mechanics is not all sympathetic to the view that this is where the proto-mentality shows up. Nevertheless it is

clear that Shimony believes that, at some stage in the development of science, and in some unspecified way, the 'dual aspect of reality will have to be taken into account.

new para

Another notion that Shimony takes very seriously is that of potentiality. In standard accounts of the measurement problem in quantum mechanics it is maintained that when the state of a microsystem is not an eigenstate of an observable, then that observable does not possess an actual value but only a potential value to be revealed on measurement, the range of such potential values corresponding to the non-vanishing components in the ~~eigenfunction exp~~ eigenvector expansion of the state in question, the squared moduli of the non-vanishing amplitudes representing the probabilities that a particular potential value will be actualized as a result of measurement.

Shimony is of course only too well aware of the problems confronting such an account. If the measurement interaction and the time-evolution of the combined state of the microsystem and the measuring apparatus is dealt with by the standard procedures of the formalism of quantum mechanics i.e. in terms of the linear, unitary, time-evolution as dictated by the time-dependent Schrödinger equation, then both the measuring apparatus and the microsystem

arrive in a superposed state, with no actual outcome, but only 'a deferred potential outcome' for the macroscopic state of the apparatus. So to put the matter in a nut-shell, 'potentialities never get actualized'. This is the famous 'problem of measurement' in quantum mechanics. Indeed, in work conducted jointly with his student, Mary Fehrs, Shimony contributed significantly to an ongoing programme of demonstrating the insolubility of the measurement problem under very general accounts of what counts as a measurement. This work is included in Volume II of these collected papers.

Shimony is generally in favour of a modified quantum dynamics, involving stochastic and/or non-linear modifications of the standard deterministic and linear evolution of the quantum state. But he is also well aware of the difficulties of producing a viable modified quantum dynamics. His attitude to ongoing work in this direction of people like Ghirardi, Rimini, Weber, Pearle, Gisin and others he describes as 'exploratory and empiricist'. Shimony sets out very fairly the desiderata for any such modified quantum dynamics. The proposed modifications should not be restricted to measurement situations, it must agree with the unmodified theory in the domain of successful applications of the latter, applied to measurement situations it should 'predict definite outcomes that arise

over a sufficiently short time scale, and any lack of definiteness of the outcome must lie beyond the limits of sensory discrimination; the modified dynamics should be Lorentz invariant, and incapable of superluminal transmission of information; it should preclude states of a system in which macroscopic variables are indefinite, except perhaps over very short time scales; and finally it should be capable of accounting for the definite occurrence of outcomes in real measurements, as opposed to idealized models of the measuring apparatus.

Shimony is doubtful that any of the proposed modifications meet all these desiderata, but remains optimistic that this is a very promising line of research in the foundations of quantum mechanics.

Of course the hidden-variables approach of people like David Bohm give a very detailed ~~a~~ and visualizable account of what goes on in measurement situations, but Shimony dismisses these approaches due to the space-like nonlocality associated with such interpretations of quantum mechanics. Shimony himself has of course been at the forefront of the nonlocality issue in hidden-variables theories and a number of his fundamental papers on this question are published in Volume II. The main achievement here of Shimony and his collaborators was to transform the idealized discussion of the Bell inequality

and its violation, into the nitty gritty of real experiments that could be carried out in the laboratory. Shimony has a great flair for investigating the details of real physical experiments and his discussion of the Bell-type experiments is masterly and authoritative. However I am not totally in agreement with Shimony's assessment of the state of play in the nonlocality argument. [Shimony ~~feels that some form of~~ is at pains to follow Jarrett in distinguishing two types of nonlocality, ~~or the violation of~~ either of which could be used to account for the violation of the Bell inequality in the context of so-called stochastic hidden-variable theories in which the complete state of the source ~~and/or the apparatus~~ is linked stochastically to the measurement outcomes on the two wings of the Bell experiment. The first assumption required for the proof of the Bell inequality is what Shimony once called the negation of controllable nonlocality but he now prefers the locution 'parameter independence'. This means that the probability of an outcome on one wing of the experiment, conditionalized on a fixed value of the hidden variable λ, is independent of the parameter setting associated with the type of experiment being performed on the other wing. Violation of parameter independence would seem to constitute a clear violation of special relativity's prohibition on superluminal signalling. But the more subtle and interesting assumption, which Shimony used to call the negation of

uncontrollable nonlocality, but for which he now uses the much better terminology of outcome independence. This asserts that, for fixed parameter settings the probability of an outcome on one wing of the experiment conditionalized on a given value of λ and on the outcome on the other wing of the experiment is independent of the latter outcome. Violation of outcome independence appears to deny that λ is the common cause of the correlations between the outcomes according to Reichenbach's principle of the common cause, asserting that the common cause 'screens off' one correlated event from the other.

Now if the quantum-mechanical state is taken to be the complete state then outcome independence is famously violated, whereas parameter independence is not.

~~Shimony writes~~. With reference to the violation of outcome independence, Shimony writes 'even if one abstains from using a causal locution in this situation, the very fact that the ~~complete~~ correlation cannot be attributed to the complete state λ constitutes a kind of nonlocality (which perhaps is sui generis and appropriately named "passion at a distance")'. It is well-known that violation of outcome independence does not of itself permit superluminal signalling, and hence seems to be incompatible with upsetting peaceful coexistence (another of Shimony's apt phrases) between quantum mechanics and relativity.

Ensemble

*, roughly that ~~ultimately~~ causal analysis always arrives at a situation ~~where~~ the probability of the effect does not depends on how the causes are themselves brought about, and this arguably fails to hold in respect of the violation of outcome independence in the Bell experiment. (see, for example, M. Redhead, 'Propensities, Correlations and Metaphysics', Foundations of Physics 22 (1992) 381–394)

Everything depends on what one takes special relativity to be prohibiting. If superluminal signalling then the violation of outcome independence is perfectly acceptable; if space-like causality, then again arguments can be given that the action involved is not causal. Shimony admits as much in the above quotation and the present reviewer has tried to fill out the argument here by urging an additional condition of 'robustness' as necessary for causality, ~~which arguably fails to hold in respect of the violation of outcome independence — in the case where the quantum-mechanical description of the state is assumed to be complete.~~ Rupli* [It is therefore a little surprising to ~~not~~ find Shimony making the following claim, 'the work initiated by Bell has the consequence of making virtually inescapable a philosophically radical interpretation of quantum mechanics: that there is a modality of existence of physical systems which is somehow intermediate between bare logical possibility and full actuality, namely the modality of potentiality.' (my italics).

Another way to go, is to blame the violation of the Bell inequality on the failure of separability rather than of locality. The distinction here is a subtle one, arguably to be found in Einstein's own writings, between properties of physical systems being possessed independently of the

holistic context and the prohibition of nonlocal action between ~~properties~~ non-holistically possessed properties. Shimony makes a brief mention of this distinction in the 'Comment' section to the paper 'Physical and Philosophical Issues in the Bohr–Einstein Debate', but I would have liked to see more discussion of ~~this~~ the intriguing metaphysical possibility of attributing the violation of the Bell inequality to a failure of separability in the sense indicated.

Returning to more general issues in philosophy of science, Shimony has written extensively on the Bayesian approach to epistemic probability and the problems of inductive inference. His major papers in this area are included in the collection under review. Here is his famous challenge ~~to~~ (originally presented in ~~conjunction~~ collaboration with K. Friedman) that Jaynes's maximum entropy approach to inductive inference, with its extensive application to the foundations of statistical mechanics, is actually inconsistent with Bayesian 'conditionalization'. It is very useful to have the up-dating 'Comment' section guiding us through the burgeoning literature on this topic, and ~~detailing~~ listing Shimony's detailed replies to his critics ~~on the subject~~. Indeed Shimony here makes out a very fair and convincing case for his arguments and I certainly agree with his final conclusion, 'the criticism of Jaynes by Friedman, Dias and me, [illegible]

Insertion

* and auxiliary assumptions and background knowledge a

the need for a retrenchment somewhere, either of PME or of Bayesian probability theory, but it does not say where the retrenchment should be made.

Finally, I turn to the paper 'Scientific Inference', in which Shimony developed his influential notion of tempered personalism. This is an attempt to deal with the problem of prior probabilities in the Bayesian approach to confirmation theory. Suppose we have a collection $\{h_i\}$ of seriously proposed hypotheses and consider the posterior probability of some particular hypothesis h_i in the light of evidence e ~~and background knowledge b~~. According to Bayes's theorem this is given by ~~the~~ formula ~~Prob(hi/e) = Prob(e/hi). Prob(hi)~~

$$\cancel{\text{Prob}(h_i/e) = \frac{\text{Prob}(e/h_i)\cdot\text{Prob}(h_i)}{\text{Prob}(e)}}$$

~~where the prior probability Prob(hi)~~

$$\text{Prob}(h_i/e\,\&\,a) = \frac{\text{Prob}(e/h_i\,\&\,a)\cdot\text{Prob}(h_i/a)}{\text{Prob}(e/a)} \qquad (1)$$

If the likelihood function $\text{Prob}(e/h_i\&a)$ is large and the probability of ~~the~~ evidence e on background knowledge is small, then the posterior probability of h_i can become large, provided the prior probability $\text{Prob}(h_i/a)$ is not too small.

If the probabilities are identified with purely subjective degrees of belief, then some priors may be so small, that no amount of favourable evidence can bring them up to a respectable posterior value. The tempering condition is supposed to deal with this problem. This consists in demanding that 'the prior probability ... of each seriously proposed hypothesis must be sufficiently high to allow the possibility that it will be preferred to all rival, seriously proposed hypotheses as a result of the envisaged observations'.

Intuitively the tempering condition reflects an attitude of suitable 'open-mindedness' on the part of the investigator: as Shimony puts it, 'the tempering condition ... prescribes that seriously proposed hypotheses be given an opportunity to show their virtues under scrutiny'.

Various problems present themselves. What about the catch-all hypothesis which is the negation of $h_1 \vee h_2 \ldots$, i.e. of the disjunction of the positively proposed hypotheses h_1, h_2 etc. Should not the 'catch-all hypothesis' itself be regarded as seriously proposed and indeed afforded a high prior on the grounds that the ultimate truth will always lie outside the logical space constrained by our current scientific theorizing? Shimony deals with the problem of the catch-all hypothesis with a concept of commitment as opposed to belief. Commitment is roughly an attitude ~~a belief~~ not that a hypothesis is true, but that it points

the way to the truth, in ~~some~~ the sense of the so-called 'correspondence principle', so that the true theory retains the approximate empirical adequacy of the hypothesis h while its concepts are generalizations or more complete realizations of these of h.

The commitment to the catch-all may then be very low.

It is clear that the concept of commitment is in need of substantial filling out and this is clearly recognized by Shimony. It involves some affinity with Popperian verisimilitude insofar as it substitutes truth with approach to the truth or nearness to the truth while the idea of correspondence needs careful analysis seeking as it does to trace continuity across so-called scientific revolutions, but the notion of continuity involved is a delicate one to capture with precision, even if it is taken at the structural level rather than the ontological level.

It is clear from (i) that Bayesianism allows no discrimination between hypotheses with the same empirical adequacy other than what is loaded into the priors. Essentially what the evidence e achieves in Bayesian conditionalization is to reduce to zero the probability of any hypothesis inconsistent with e and to redistribute the probability amongst all hypotheses consistent with e in exactly the same proportions as ~~to~~ obtains amid the priors

So Bayesian conditionalization is really an eliminative procedure. this is recognized by Shimony, but a problem he does not address is that of 'old evidence', i.e. can an already known observation provide confirmation for an hypothesis? In equation (*) if we substitute unity for the likelihood and the probability of the evidence, we just get

$$\text{Prob}(h_i / e \& a) = \text{Prob}(h_i / a) \quad \text{---}(2)$$

which is what we should expect given that e is now essentially part of a.

But (2) seems to show no confirmation of hi by e, if e is already known.

But this ~~so~~ seems to go against intuitive historical examples such as the motion of the perihelion of Mercury providing support for general relativity.

Much has been written on this problem, but I believe the solution is quite simple.

If e is used heuristically as a 'filter' on theory construction, then any hypothesis that does not predict e will be ~~fed~~ filtered out and accorded zero prior probability, the ~~[illegible]~~ whole probability being spread amongst those hypotheses that do predict e, in proportion to their priors as assessed relative to a − e, i.e. background knowledge without e.

But this just means that the priors in (2)

are numerically equal to the posteriors in (1) if e is not part of a, and Bayesian conditionalization is applied. So the posterior probabilities in (1) and (2) are actually equal, although calculated in quite different ways according as e is new or old evidence.

I think this solution does full justice to the historical examples, and I must say would have liked to hear Shimony's own views on this notorious problem.

In later work Shimony has retreated from regarding the tempering condition as an additional constraint that might lead to inconsistency with the other axioms of probability, and appeals to degrees of commitment more helpfully in terms of belief in approximate truth, in the ~~early~~ sense described above. He calls this 'tempering without tempering', and it seems a very sensible emendation of his earlier characterization.

Shimony wisely observes that the success of scientific inference is in no way guaranteed by a priori reasoning, but depends crucially on the nature of the world and the really inexplicable abductive powers of human beings. Shimony regards it as a brute fact that 'the hypotheses seriously proposed by men immersed in their subject are statistically much more likely to contain a good approximation to the truth than an equal number of hypotheses

selected from among all possibilities by a random process'. He warns moreover, 'it is an uncertain extrapolation to suppose that nature will continue to favour human abductive powers in domains increasingly remote from our immediate concerns'. Here indeed is the nub of the problem of closing the circle in a naturalistic world view, but while Shimony is fully aware of the problem, he does little in a positive sense to provide any genuine understanding of how the trick is pulled. In some way the external world and the human mind are in tune, but none of us have any real inkling of how this is possible in the arcane world of trans-commonsensical theoretical physics!

I have only touched on some of the more important themes running through these collected papers. There is much more of interest ranging from the psychology of perception to the relations of parts and wholes in atomic molecular and solid state physics, and including some important views on the nature of time. But I ~~have~~ hope I have said enough to illustrate some of the range and profundity of Shimony's work. There is scarcely a problem that he treats of that is not illuminated and clarified

by his penetrating powers of analysis, and by his transparent honesty in facing up to every difficulty confronting his proposed solutions.